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Environmental assessment of spatial distribution of zooplankton community in Lake Manzalah, Egypt

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Lake Manzalah is the largest of the four Nile Delta lakes in Egypt. It provides more than 50% of the total inland fisheries of the country. During the last two decades the Lake has been exposed to multiple changes mainly due to local human activities. Monthly zooplankton samples were collected during an integrated environmental monitoring program within the MELMARINA Project that extended from July 2003 to September 2004 to study the distribution and occurrence of zooplankton community in Lake Manzalah.

Results showed that, the average zooplankton standing crop was 1277 x 10^3 individuals m^{-3}. Spring was the most productive season (2127 x 10^3 individuals m^{-3}) representing 41.65% to the total zooplankton counts. Five groups dominated zooplankton community; Rotifera, Copepoda, Ostracoda, Protozoa and Cladocera. The meroplanktonic larvae of Polychaeta, Cirripedia, Mysidacea and Gastropoda as well as free living nematods were rarely recorded.

Rotifera contributed 81.89% to the total zooplankton community. They were represented by 38 species belonging to 19 genera dominated by genus Brachionus *(86.65% of the total Rotifera) followed by genus* Keratella *(8.68%).* Keratella *species has been indicated as an indicator of pollution.*

Copepoda (including their larval stages) was the second group in order of abundance forming about 14.28% of the total zooplankton counts and represented by seven species. Acanthocyclops americanus *was the dominant species.*

The productivity of Lake Manzalah decreased from 1979 to become highly eutrophic lake during the present study, but with higher production than the other Egyptian lakes. Management is needed to stabilize the Manzalah lake ecosystem in a way that promotes the sustainability of the system.

Key words: Zooplankton, Lake Manzalah, Egyptian waters, abundance, community characteristics

INTRODUCTION

Lake Manzalah is the largest of the northern Nile Delta coastal lakes in Egypt. The importance of this lake is not only dependent on its size but also on its high productivity. It is a major multi purpose resource and during the 1970's, the fish catch of Lake Manzalah represented almost 50% of the total catch of the inland waters in Egypt but fish stocks have declined sharply in recent years. Particularly during the last two decades the lake has been subjected to multiple changes and intensifying human activities. These activities are on-going and include unsustainable practices such as land reclamation for agricultural and building purposes, over fishing and illegal fishing, developments of roads around the lake, and growth of industrial areas in the north western and north eastern sectors. Effluent discharges are however probably the most significant problem, since sewage drainage systems open into the lake through several drains that deliver sewage from more than three governorates.

The aquatic ecosystem of Manzalah is a major concern since good ecosystem health is essential not only for sustaining lake services to local populations but also for maintaining biodiversity. In 2003 an integrated monitoringg project was begun, the MELMARINA Project. This EU supported research initiated integrated monitoring and explores the importance of a coastal information system based on satellite remote sensing and ground truth data for coastal and marine areas. MELMARINA is designed to help understand the current status of Manzalah and also to help predict the future changes in the eco-hydrological status of North African lagoons generally. One important aspect of the aquatic ecosystem in Lake Manzalah is the zooplankton community which plays a vital role in carbon cycling and provides a food resource for fish. Relatively little is known about plankton in Lake Manzalah. Some notes on the occurrence of the characteristic zooplankton organisms of Lake Manzalah were given by the Cambridge Expedition to the Suez Canal in 1924 (FOX, 1926) and these were followed by the studies of FAOUZI (1937), ELSTER & VOLLENWEIDER (1961) and EL-MAGHRABY *et al.* (1963). More recently, ecological study of zooplankton and distribution of macrofauna in Lake Manzalah were carried out by GUERGUESS (1979, 1983). The distribution of rotifers and their relative abundance in the Egyptian inland waters, especially in Lake Manzalah, were studied by GUERGUESS (1986a, b; 1993). HALIM & GUERGUESS (1981) studied the zooplankton in the coastal lakes of the Nile Delta and effect of pollution on the productivity of Lake Manzalah was investigated by EL-SHERIF *et al.* (1994).

In view of the increased role of the drain water reaching the lake, in the last 20 years, important changes have taken place in the water, bottom sediment quality and biota. The objective of the present work is to study the distribution and occurrence of zooplankton community in Lake Manzalah.

MATERIAL AND METHODS

Study area

Lake Manzalah is rectangular in shape with its longer axis (about 65 km) directed from northwest to southeast. Its greatest width is

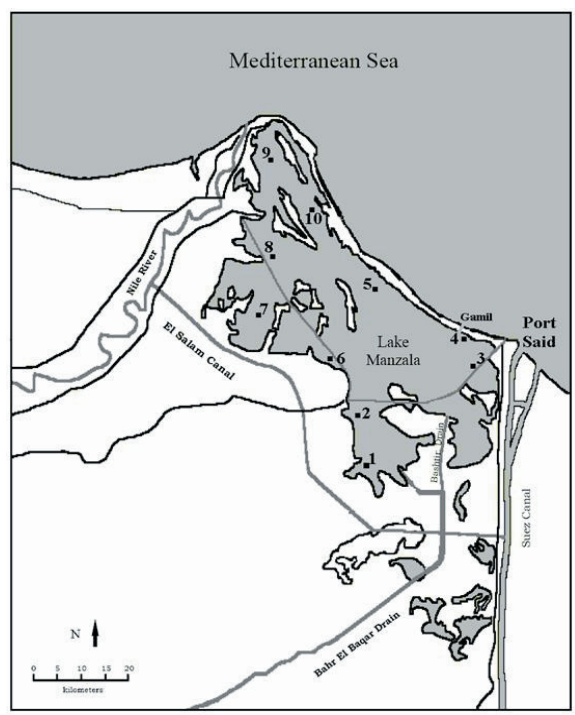

Fig.1. Lake Manzalah and locations of the sampling stations

approximately 45 km and has an area of about 700 km^2 (Fig. 1).

The lake is shallow with an average depth of about one meter. 25% of the lake is less than 60 cm in depth, 50% within the range of 60-100 cm, while the remaining 25% is more than 100 cm deep (SHAHEEN & YOSEF, 1978). The lake is connected to the Mediterranean Sea by Boughaz El-Gamil and the depth of this channel is about 6.5 m and width is about 100 m. The channel therefore exerts a strong influence on the salinity of the lake in the northern sections. In the southern sectors four drains conduct essentially freshwater and also pollution to the lake.

Sampling methods

Ten sampling stations were selected to represent the different habitats in the lake. Fig. 1 illustrates Lake Manzalah and the locations of the sampling stations. At each station, zooplankton samples were collected monthly during the period July 2003 - September 2004. The zooplankton samples were collected by filtering 50 litres of lake water through a small standard plankton net (mesh size 55 μm) using a plastic container of litres capacity. The collected samples were preserved directly with 4% neutral formaline solution in 250 ml polyethylene bottles. The volume of each sample was concentrated to 100 ml and the whole sample was examined in a Petri dish under a research binocular microscope. For zooplankton enumeration purposes, at least two aliquots (2 ml of well shaken suspension) were withdrawn from each sample using a graduated pipette, placed in a counting chamber and the number of individuals of each species was counted. The average number of duplicate examination for each sample was estimated and the counts were expressed as number of organisms per cubic meter.

For the identification of the different species of zooplankton the following textbooks were consulted; GURNEY (1926, 1931, 1932, 1933), TREGOUBOFF & ROSE (1957), EDMONDSON (1959) and HUTCHINSON (1967).

RESULTS

The physico-chemical parameters of Lake Manzalah (for July 2003 - September 2004) were record. Water temperature ranged between a minimum value of 15.20 °C in winter to a maximum one of 31.30 °C in summer, with an average of 22.80 °C. Salinity varied from 1.43 in spring to 20.30 in summer having an average of 6.10. Lake Manzalah is well oxygenated where the dissolved oxygen was 6.70 mg l^{-1} summer. It increased to maximum values of 18.36 mg l^{-1} in winter. The pH was affected by the fresh and brackish water inflow into the lake through the drains and ranged from 6.30 to 9.27, which is amounted by 6692 x 10^6 m^{-3} freshwater per year (SAID & ABDEL MOATI, 1995).

Zooplankton community characteristics

The monthly variations of the total zooplankton counts and for the different groups in Lake Manzalah during the 15-month study period are shown in Fig. 2. The minimum zooplankton densities were recorded in July and August 2003 (444 and 624×10^3 org m^{-3} respectively). Two peaks of abundance were observed, the major one was recorded in April (average 2845×10^3 org m^{-3}) and the second peak appeared in March with an average of 2277×10^3 org m^{-3}. Relatively small peaks were observed in December (average 1691×10^3 org m^{-3}) and June (average 1542×10^3 org m^{-3}). All these peaks mainly comprised rotifers and copepods. The annual average of zooplankton standing stock in the lake was 1277×10^3 org m^{-3}.

The zooplankton community recorded during the present study comprised 63 species included in five groups: Rotifera, Copepoda, Ostracoda, Protozoa and Cladocera. They constituted collectively about 98.68% of the total zooplankton. Rotifera contributed about 81.89% to the total zooplankton community (Fig. 3), with an annual average of 1045×10^3 org m^{-3}. They were represented by 38 species belonging to 19 genera. The genus *Brachionus* (86.65% of the total Rotifera) dominated and comprised 8 spe-

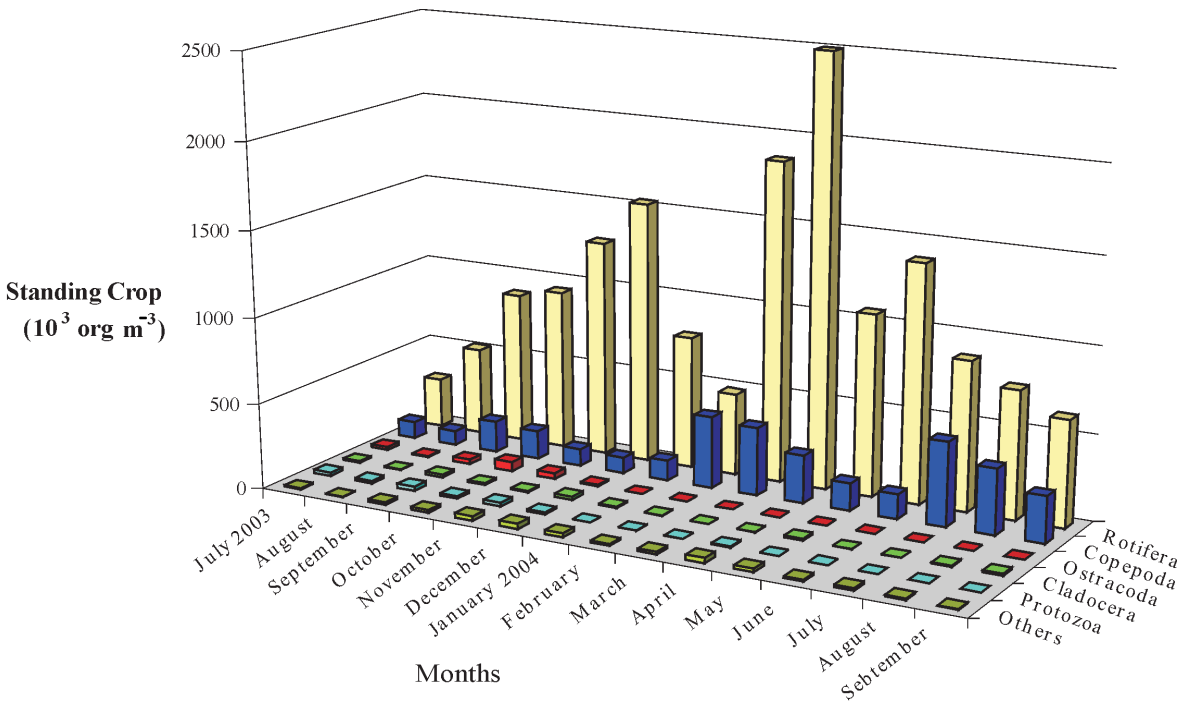

Fig. 2. Monthly distribution of the total zooplankton in Lake Manzalah during the study period

cies, followed by genus *Keratella* (8.68%). Four species dominated Rotifera; *Brachionus angularis* (34.18%), *B. urceolaris* (20.29%), *B. calyciflorus* (18.61%) and *B. plicatilis* (13.26%).

Copepoda and their larval stages were the second most abundant group, with an annual average of 182×10^3 org m^{-3} and representing 14.28% of the total zooplankton. Copepods

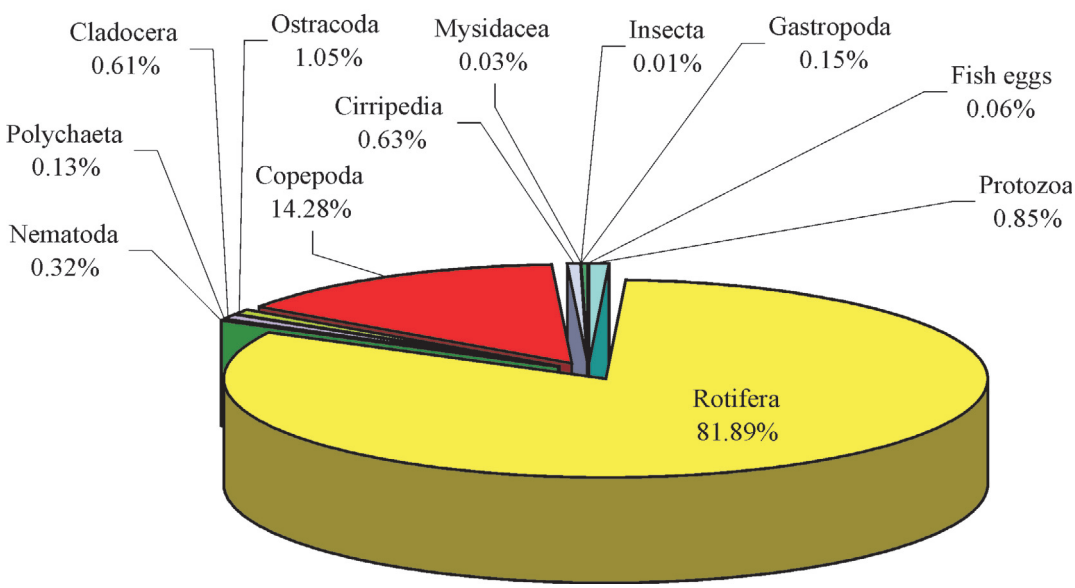

Fig. 3. Percentage of occurrence of the recorded zooplankton groups in Lake Manzalah during the study period

were represented by 7 species belonging to 6 genera and dominated by genus *Acanthocyclops*. The nauplii predominated over the adults (141 $\times 10^3$ org m^{-3}) representing 77.41% of the total copepods. Two marine copepod species were recorded; *Oithona nana* and *Euterpina acutifrons*.

Ostracods and their nauplii occupied the third order of abundance (14×10^3 ind m^{-3}) contributing 1.05% to the total average crop.

Cladocera (average 8×10^3 ind m^{-3}) contributed 0.61% to the total community. They were represented by 5 species with *Moina micrura* and *Alona bukobensis* as the dominant species.

Protozoa contributed 0.85% to the total zooplankton counts, with an annual average of 11×10^3 ind m^{-3}. They were represented by the members of Zooflagellata, Rhizopoda and Ciliophora.

Other groups such as Nematoda, Polychaeta, Cirripedia, Mysidacea, Insecta, Gastropoda and fish eggs were rarely recorded and contributed collectively 1.3% to the total zooplankton community.

Zooplankton community distributions

Regional distribution of the total zooplankton throughout the study period showed that, the highest standing stock of zooplankton in the lake (average 2660×10^3 ind m^{-3} and 2300×10^3 ind m^{-3} respectively) occurred at stations 3 and 1 (Fig. 4). Rotifera dominated numerically over other groups. Their peaks of abundance were attained at stations 3 and 1 (2185×10^3 ind m^{-3} and 1733×10^3 ind m^{-3} respectively). These stations were characterized by high dissolved oxygen content (14.48 and 10.32 mg l^{-1} respectively). The lowest density of zooplankton appeared at stations 7 and 9 (559×10^3 ind m^{-3} and 613×10^3 ind m^{-3} respectively), directly affected by the drainage water from the drains.

The lowest zooplankton standing crop was recorded at stations 2 and 7 during July 2003 (40×10^3 ind m^{-3} and 162×10^3 ind m^{-3}

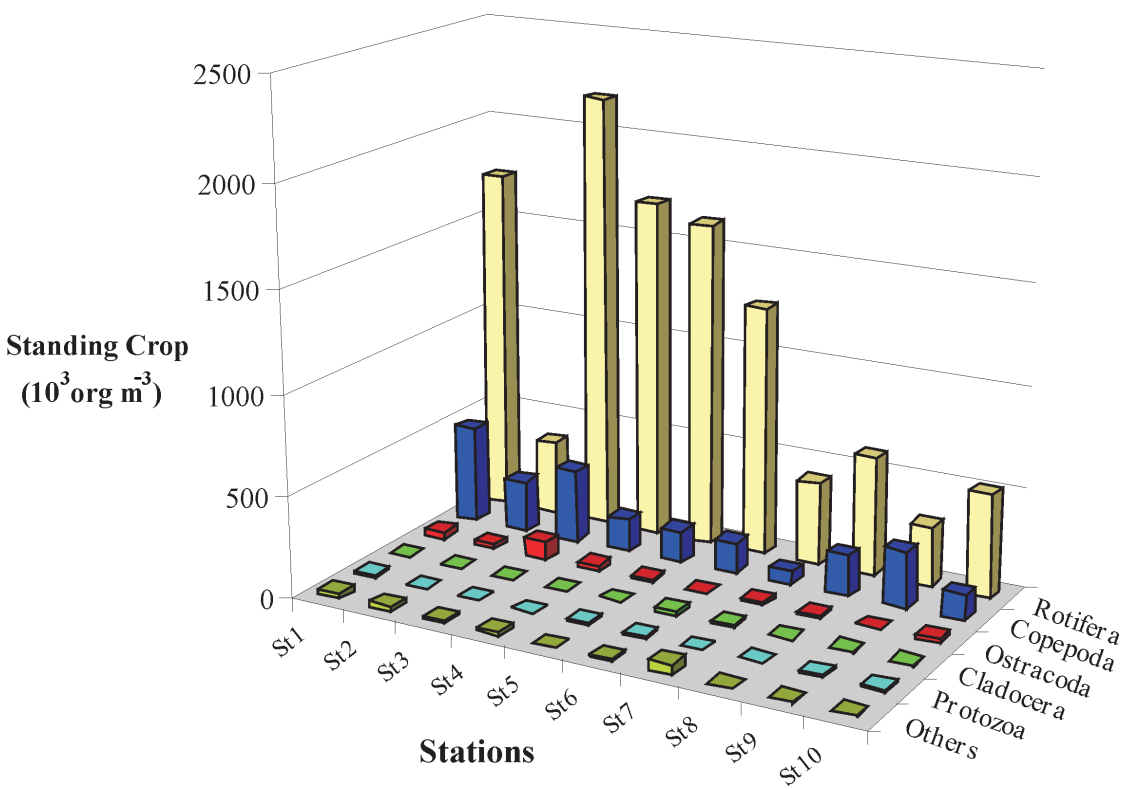

Fig. 4. Spatial distribution of the dominant zooplankton groups in Lake Manzalah during the study period

respectively). These two stations contributed the highest TDS (total dissolved solids) (27.30 and 24.54 g l^{-1}), high salinity (35.70 and 31.77), high temperature (>29 °C) and low pH (7.97 and 7.92) respectively. Rotifer dominance was conspicuous during July at all station except stations 2 and 7, where copepods were the dominant group.

Seasonal variations

Seasonal variations of the numerical density of the total zooplankton and their different groups are shown in Table 1. The average standing crop of zooplankton during summer 2003 was 534×10^3 ind m^{-3}, i.e. about 10.46% of the total zooplankton crop.

Rotifera dominated zooplankton community (404×10^3 ind m^{-3}) constituting about 75.66% of the total zooplankton during summer 2003 (Table 1). They were represented by 10 species: *Brachionus urcoeolaris, B. plicatilis*, *B. calyciflorus*, *B. angularis, Lecane (Monostyla) lunaris*, *L.* (*M.) closterocerca, L. (M.) bulla, L. luna, Lepadella ovalis* and *Polyarthra vulgaris*. Among them, *Brachionus urcoeolaris* (75.59% of the total Rotifera), *B. calyciflorus* (10.84%) and *B. plicatilis* (9.33%*)* were dominant.

Copepoda (including their larval stages) was the second group in order of abundance, with an average of 91 x 10^3 ind m^{-3} and forming about 16.95% of the total zooplankton community. They were represented by *Acanthocyclops americanus, A. vernalis, Nitocra lacustris* and *Thermocyclops crassus*. Copepod nauplii formed about 72.15% of the total copepod population.

Protozoa, Ostracoda and Cladocera were less frequent, constituting 3.13%, 2.26%, and 1.14% of the total zooplankton respectively. Zooflagellates (*Ancyromonas contorta*), ciliophores (*Vasicola ciliata, Glaucoma scintillans, Stokesia vernalis*, *Tintinnidium fluviatile* and *Favella ehrenbergii*) represented protozoan population during summer. Other groups, such as Polychaeta, Cirripedia and Mysidacea as well as free living nematods were represented by their larval forms. They occurred rarely and collectively represented 0.86% of the total zooplankton.

Table 1. Seasonal distribution of the recorded zooplankton groups (indviduals m^{-3}) and their percentage frequency in Lake Manzalah during 2003-2004

Seasons / Groups	Summer		Autumn		Winter		Spring		Average	
	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%	No m^{-3}	%
Protozoa	16700	3.13	20330	1.60	3605	0.31	2778	0.13	10853	0.85
Rotifera	404000	75.66	1030930	81.20	928847	78.97	1817590	85.46	1045342	81.89
Nematoda	500	0.09	3200	0.25	11133	0.95	1733	0.08	4142	0.32
Polychaeta	2400	0.45	2730	0.22	200	0.02	1089	0.05	1605	0.13
Cladocera	6100	1.14	11000	0.87	9819	0.83	4422	0.21	7835	0.61
Ostracoda	12100	2.26	38930	3.07	2867	0.24	0	0.00	13474	1.05
Copepoda	90500	16.95	149530	11.78	209354	17.80	279741	13.15	182281	14.28
Cirripedia	1400	0.26	9200	0.72	7401	0.63	13965	0.65	7991	0.63
Mysidacea	300	0.06	870	0.07	67	0.01	67	0.01	326	0.03
Insecta	0	0.00	100	0.01	67	0.01	44	0.01	53	0.01
Gastropoda	0	0.00	270	0.02	2533	0.21	5096	0.24	1975	0.15
Fish eggs	0	0.00	2400	0.19	267	0.02	178	0.01	711	0.06
Total	534000	100	1269490	100	1176160	100	2126703	100	1276588	100

The zooplankton community which was observed in summer 2003 was much different from that of summer 2004. On average, the standing crop of the zooplankton in summer 2004 was 1354×10^3 ind m^{-3}. Protozoa and Mysidacea were not represented during that season. Rotifera were represented by 21 species, contributing 74.07% to the total zooplankton. *Brachionus plicatilis, B.angularis, B.calyciflorus* and *Hexarthra mira* were dominant. Copepoda and their larval stages constituted 24.93% of the total zooplankton. *Thermocyclops crassus* was recorded during summer 2003 but not in summer 2004.

During autumn the zooplankton abundance increased with the mean density of 1270×10^3 ind m^{-3}, representing 24.86% of the total zooplankton (Table 1). The zooplankton community was dominated by Rotifera, which contributed about 81.2% to the total zooplankton community with an average of 1031×10^3 ind m^{-3}. They were represented by 26 species belonging to 14 genera. *Brachionus urcoeolaris, B. calyciflorus* and *B. angularis* were the dominant species, contributing 45.05%, 27.73% and 21.87% to the total Rotifera respectively. *Lecane* (*Monostyla) closterocerca, Polyarthra vulgaris* and *Ascomorpha saltans* were the frequent species.

Total copepods (including larval stages) contributed 11.78% to the total zooplankton community. This percentage was relatively low compared to that during summer. They were represented by 7 species: *Acanthocyclops americanus, A. vernalis, Thermocyclops crassus, Eucyclops sepratus, Nitocra lacustris, Oithona nana,* and *Euterpina acutifrons*. Among them, the last two species belong to the inshore neritic marine forms.

Ostracods and their nauplii (average 39×10^3 ind m^{-3}) contributed about 3.07% to the total community. Protozoa were represented by members of 4 different orders; Zooflagellata, Ciliata and Rhizopoda. They amounted together to an average of 20×10^3 org m^{-3} forming 1.60% of the total community. Cladocera (average 11×10^3 ind m^{-3}) contributed about 0.87% to the total community. They were represented by three species; *Moina micrura*, *Alona bukobensis* and *Diaphanosoma exisum*. Polychaeta, Cirripedia, Gastropoda, Insecta larvae and free-living nematods were rarely recorded and contributed collectively 1.48% to the total zooplankton community.

During winter, the average standing crop of zooplankton in the lake was 1176×10^3 ind m^{-3}, forming 23.03% of the total zooplankton. Rotifera was by far the most dominant zooplankton group with an average density of 929×10^3 ind m^{-3} and a contribution of 78.97% to the total community. Regarding the species composition, Rotifera was highly diversified (27 species). *Brachionus calyciflorus* (30.01% of the total Rotifera), *Keratella quadrata* (29.16%) and *B. angularis* (19.35%) were the dominant species.

Copepoda were the second dominant group with an average density of 209×10^3 ind m^{-3}, accounting for 17.8% of the total average crop. This percentage was relatively high in comparison with the other seasons. *Acanthocyclops americanus, A. vernalis*, *Nitocra lacustris* and *Oithona nana* as well as their larval stages (nauplii and copepodite stages) represented copepod population in the lake during winter.

Nematoda, Cladocera and Protozoa represented 0.95%, 0.83% and 0.31%, of the total zooplankton community respectively. Other zooplankton groups were represented by their larval forms such as Polychaeta, Ostracoda, Cirripedia Mysidacea, Insecta as well as Gastropoda were rarely represented, contributing collectively 1.14% of the total zooplankton community.

The highest zooplankton standing crop was recorded during spring (average 2127×10^3 ind m^{-3}), representing 41.65% of the total zooplankton counts. Rotifera were dominant during this season (1818×10^3 ind m^{-3}), forming 85.46% of the total community. The dominant species were *Brachionus angularis* (56.07%), *B. plicatilis* (26.41%) and *B. calyciflorus* (9.34%). Copepoda attained their highest values in spring (279.7×10^3 ind m^{-3}), representing 13.15% of the total community. They were dominated

by *Acanthocyclops americanus*. Nauplius and copepodite stages were the main components, contributing 95.78% to the total copepods. Cirriped nauplii, gastropod veligers and cladocerans represented 0.66%, 0.24% and 0.21% of the total zooplankton community respectively. Other groups were rarely recorded, contributing collectively 0.28% to the total community.

DISCUSSION

Quantitative and qualitative study of the zooplankton communities in Lake Manzalah during the 15-month study period (July 2003 - September 2004) showed that the annual average zooplankton standing crop was 1277×10^3 ind m^{-3}. This value indicated that the lake is highly productive area when compared with Lake Burollus which estimated 183×10^3 ind m^{-3} during 1987 (ABUL EZZ, 1995) and Lake Maryout with approximately 117×10^3 ind m^{-3} during 1996-1997 (ABDEL AZIZ & ABOUL EZZ, 2004) and Lake Idku of 326×10^3 ind m^{-3} during 2000 (ABOUL EZZ & SOLIMAN, 2000). But it is lower than that recorded in Lake Manzalah during 1990 by EL-SHERIF *et al.* (1994), which amounted to 5×10^6 ind m^{-3}.

Regional distribution of the total zooplankton throughout the study period showed that the highest standing crop (2185×10^3 ind m^{-3}) occurred at the northern part of the lake. This area characterized by high dissolved oxygen content (14.48 mgO_2 l^{-1}).This agrees with the opinion of TRAIN (1979) who mentioned that the amount of dissolved oxygen required the healthy growth of fresh water biota must be over 5 mlO_2 l^{-1} (>7.14 mgO_2 l^{-1}). On the other side, the southern part of the lake has the lowest zooplankton crop (40×10^3 ind m^{-3}). This may be attributed to water quality where the samples were highly turbid with organic matter and suspended sediment.

Rotifers are known to be excellent indicators of organic pollution as they thrive better in organically rich environment Comparative investigation of the Egyptian lagoons showed that cleaner environments are the lowest in standing crop as well as in species richness, whereas eutrophic areas sustain the greatest number of both individuals and species but only up to a certain level (GUERGUESS, 1992). GUERGUESS (1979) mentioned that the standing crop of zooplankton in Lake Manzalah was 63 x 10^3 ind m^{-3}, 24% being rotifers and represented by 16 species. EL-SHERIF *et al.* (1994) recorded that the average zooplankton on the lake was 5×10^6 ind m^{-3}. Rotifera contributed 77% and were represented by 20 species. In the present study, Rotifera predominated over the other zooplankton groups in the lake and contributed about 81.89% to the total zooplankton community with an annual average of 1045×10^3 ind m^{-3}. They were represented by 38 species belonging to 19 genera dominated by genus *Brachionus* (86.65% of the total Rotifera) followed by genus *Keratella* (8.68%). *Keratella* species has been indicated as an indicator of pollution (BAHURA *et al.,* 1993; SUKUMARAN & DAS, 2004). Accordingly, the productivity of Lake Manzalah decreased from 1979 to become highly eutrophic lake during the present study, but still higher productive than the other Egyptian lakes.

Except in July 2003, the results apparently indicated that abiotic factors did not exert considerable influence on the rotifer abundance. During July copepods were the dominant group at the southern part of the lake. This area was characterized by high salinity (31.77-35.70), high water temperature (>29.0) and low pH (7.92-7.97). This may be explained by the fact that most rotifers can not tolerate high salinity.

The occurrence of Rotifera in Lake Manzalah over the last 45 years is shown in Table 2. There were 44 species recorded in the lake. Only two species were identified by EL-MAGHRABY *et al*. during 1959-1960 (1963). GUERGUESS (1979) recorded 16 species of Rotifera in Lake Manzalah during 1971-1973. In June 1981, 4 species were found by GUERGUESS (1986a). EL-SHERIF *et al.* (1994) identified 20 species of Rotifera in the lake during 1990. In the present study, 38 species were recorded, indicating an increase of species diversity during the last years. Of them 15 species were recorded for the first time in the lake.

Table 2. Occurrence of rotifers in Lake Manzalah in the last 45 years

Years	1959-1960	1971-1973	1981	1990	2003-2004
Species					
Anuraeopsis fissa Gosse, 1851					+
Ascomorpha saltans Bartsch, 1870		+			+
Asplanchna priodonta Gosse, 1850					+
Brachionus angularis Gosse, 1851		+		+	+
Brachionus budapestinses Daday, 1885		+		+	+
Brachionus calyciflorus Pallas, 1766		+		+	+
Brachionus caudatus Barrois & Daday, 1894		+		+	+
Brachionus falcatus Zacharias, 1898		+		+	+
Brachionus plicatilis O.F. Muller, 1786				+	+
Brachionus quadridentatus Hermann, 1783		+			+
Brachionus urceolaris O.F. Muller, 1773		+		+	+
Brachionus sp.	+				
Colurella adriatica Ehrenberg, 1831				+	+
Euclanis dilatata Ehrenberg, 1832					+
Filinia longiseta Ehrenberg, 1834				+	+
Filinia sp.		+			
Hexarthra mira Hudson, 1871				+	+
Horella brehmi Donner, 1949			+		+
Keratella cochlearis Gosse, 1851				+	+
Keratella hiemalis Carlin (1943)					+
Keratella quadrata O.F. Muller, 1786		+		+	+
Keratella tropica Apstein, 1907					+
Keratella sp.	+				
Lecane (Monostyla) bulla Gosse, 1851		+		+	+
Lecane (Monostyla) closterocerca Schmarda, 1853					+
Lecane depressa Bryce, 1891					+
Lecane elasma Herring & Myers, 1926					+
Lecane luna O.F. Muller, 1776		+		+	+
Lecane (Monostyla) lunaris Ehrenberg, 1832					+
Lecane ohioensis Harrick, 1885					+
Lepadella ovalis O.F. Muller, 1786				+	+
Lepadella patella O.F. Muller, 1786					+
Lepadella sp.			+		
Macrochaetus collinsii Gosse, 1867					+
Macrochaetus subqudatus Perty					+
Monommata grandis Tessin, 1890			+		+
Notholca labis Gosse, 1887					+
Platyias quadricornis Ehrenberg, 1832		+			
Polyarthra vulgaris Carlin, 1934		+		+	+
Rotaria neptunia Ehrenberg, 1832		+		+	+
Synchaeta okai Sudzuki, 1964			+	+	+
Synchaeta pectinata Ehrenberg, 1832				+	+
Trichocerca cylindrica Imhof, 1891				+	+
Trichocerca sp.		+			

Regarding the other Egyptian lakes, 26 species of Rotifera were recorded in Lake Burollus by ABOUL EZZ (1995), 49 species were recorded in Lake Idku (ABOUL EZZ & SOLIMAN, 2000), and 32 species were in Lake Maryout (ABDEL AZIZ & ABOUL EZZ, 2004).

Copepoda and their larval stages were the second most abundant group, representing 14.28% of the total zooplankton community. Seven species were recorded; spring was characterized by low species diversity. GUERGUESS (1979) and EL-SHERIF *et al.* (1994) recorded 12 species of copepods in the lake.

CONCLUSIONS

Examination of long term records indicated that zooplankton community composition is not stable it is changing in accordance with water quality. We believe that the increase in rotifers particularly is indicative of declining water quality and any proportional loss of Copepoda and Cladocera taxa could threaten some fish stocks. Management is needed to stabilize the Manzalah lake ecosystem in a way that promotes the sustainability of the system. One management option could involve aspects of the recently introduced water framework directive for European inland water where management strategies that promote good ecological status are advocated.

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Procjena stanja okoliša u odnosu na prostornu rasprostranjenost zooplanktonske zajednice u egipatskom jezeru Manzalah

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SAŽETAK

Jezero Manzalah najveće je od četiri jezera u egipatskom dijelu delte rijeke Nil. Iz njega se izlovljava više od 50% ukupnog ribarstva kopnenih voda u zemlji. Tijekom posljednja dva desetljeća jezero je bilo izloženo brojnim promjenama uglavnom zbog antropogenih lokalnih aktivnosti. Mjesečni uzorci zooplanktona sakupljani su za vrijeme integriranog programa praćenja stanja okoliša u sklopu projekta MELMARINA kojim se od srpnja 2003. do rujna 2004. proučavala raspodjela i učestalost zooplanktonske zajednice u jezeru Manzalah.

Rezultati su pokazali da je prosječna gustoća populacije zooplanktona iznosila 1277 jedinki m^{-3}. Tijekom proljeća je zabilježena najveća produktivnost (2127×10^3 jedinki m^{-3}) koja predstavlja 41.65% od ukupnog broja zooplanktona. U zooplanktonskoj zajednici prevladavalo je pet skupina: Rotifera, Copepoda, Ostracoda, Protozoa i Cladocera, dok su meroplanktonske larve Polychaeta, Cirripedia, Mysidacea i Gastropoda kao i slobodne živuće nematode rijetko zabilježene.

Skupina Rotifera doprinosila je 81.89% od ukupnog broja zooplanktona. Zastupljeno je 38 vrsta koje spadaju u 19 rodova kojima dominira rod *Brachionus* (86.65% od ukupnog broja Rotifera). Slijedi genus *Keratella* (8.68%) koji se smatra pokazateljem zagađenja.

Veslonošci (uključujući ličinačke stadije) su bili na drugom mjestu po zastupljenosti (14.28%), sa zabilježenih sedam vrsta, od kojih je dominantna bila *Acanthocyclops americanus*. Produktivnost jezera Manzalah je smanjena od 1979. godine i jezero je postalo vrlo eutrofično za vrijeme ove studije, no još uvijek je produktivnije od ostalih egipatskih jezera. Potrebno je ciljano upravljanje kako bi se stabilizirao ekosustav jezera Manzalah na način koji će unaprijediti održivost sistema.

Ključne riječi: zooplankton, jezero Manzalah, egipatske vode, rasprostranjenost, karakteristike zajednice